

North American Rapid Refresh Ensemble (NARRE) at the HMT-WPC Winter Weather Experiment

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Special Thanks

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Toward NARRE (SREF-RR)

- EMC Roadmap (NARRE and HRRRE)
- Two dynamic cores RAP-ARW and NMMB-NAM
- All members cycled hourly
- 12km horizontal grid spacing
- 6-8 members
- Model uncertainty addressed with use of two dycores and various physics parameterizations
- It is an extension of SREF
 - SREF runs out to 84 fcst hrs on 6-hrly cycles
 - Subset of SREF members (NARRE) update hourly and run out to 18 forecast hours
- NARRE is scheduled for implementation to operations in 2017
- Collaborative work between **EMC, GSD and DTC.**

Toward NARRE (SREF-RR)

- Pre-NARRE configuration testing
 - ARW and NAM ensemble on the same grid
 - The first joint ARW and NMMB ensemble on the same grid, rotate lat-lon
 - 12km RAP domain
 - somewhat smaller than the NAM domain
 - 8 members, 4RAP + 4NAM
 - Two 5-day periods evaluated
 - May 26-31, 2013 and January 27 – February 3, 2014
 - Test of an impact that physics changes have on pre-NARRE performance
 - Configuration tested over the warm period was applied on the cold period
 - No cycling included for testing

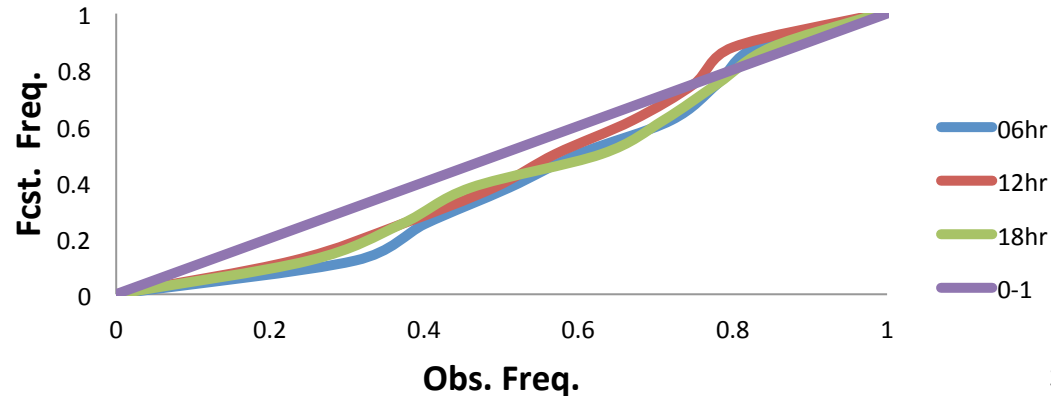
Pre-NARRE (SREF-RR) Physics Testing Findings

	MP	Sfclay	Sfcphy	PBL	CU	IC/LBs
rap ctl	Thompson	MYNN	RUC	MYNN	GF	GFS
rap1	Thompson	MO-MYJ	RUC	MYJ	BMJ	GEP01
rap2	Ferrier	MO-YSU	RUC	YSU	BMJ	GEP02
rap3	Ferrier	MO-MYJ	RUC	MYJ	BMJ	GEP03
rap4	Ferrier	MO-MYJ	NOAH	MYJ	BMJ	GEP01
rap5	Ferrier	MYNN	RUC	MYNN	GF	GEP02
rap6	Ferrier	MYNN	RUC	MYNN	BMJ	GEP03
rap7	Thompson	MO-YSU	RUC	YSU	BMJ	GEP04
rap8	Ferrier	MO-YSU	RUC	YSU	GF	GEP01
nmmb ctl	Ferrier	MYJ	NOAH	MYJ	BMJ	GFS
nmmb1	Ferrier	MYJ	NOAH	MYJ	BMJ	GEP01
nmmb2	Ferrier	MYJ	NOAH	MYJ	BMJ	GEP02
nmmb3	Ferrier	MYJ	NOAH	MYJ	BMJ	GEP03

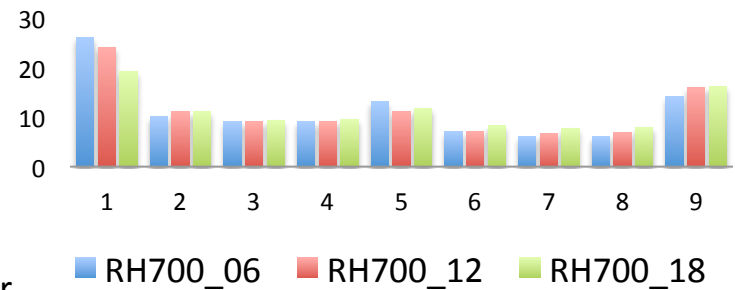
- 56 permutations (drawing 3 out of 8 RAP members), CTRL member always included
- Evaluated impact on three statistics, RMSE, Spread/Error, CRPSS using full (RAP + NAM) ensemble
- On average 8% improvement in RMSE, 10% Spread/Error, 5% CRPSS
- Chosen configuration presented in blue color

Pre-NARRE testing results

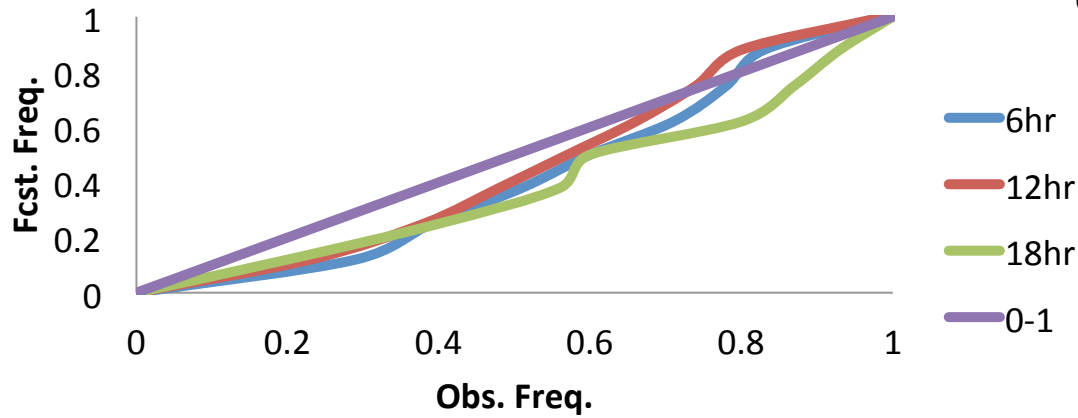
RH700 Reliability for different lead times



RH700 rank histogram for different lead times

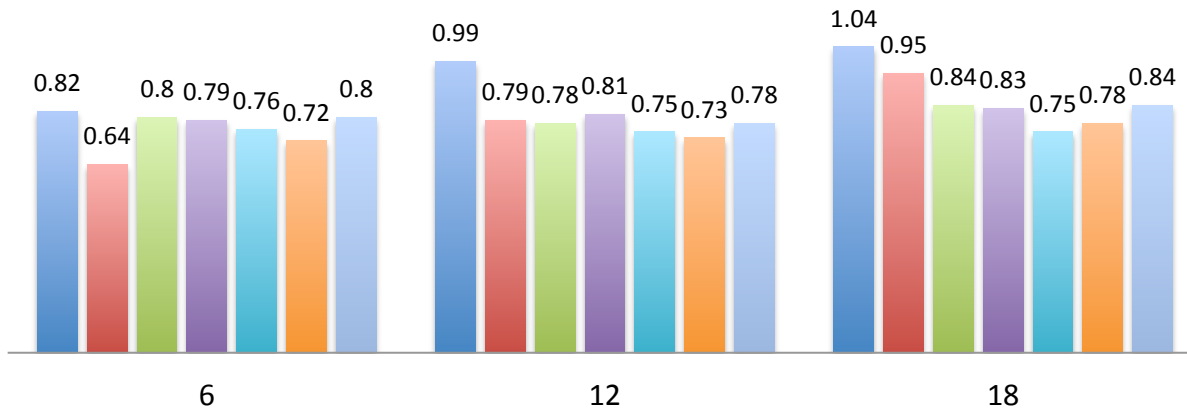


T850 Reliability for various lead times



Spread/Error for different lead times

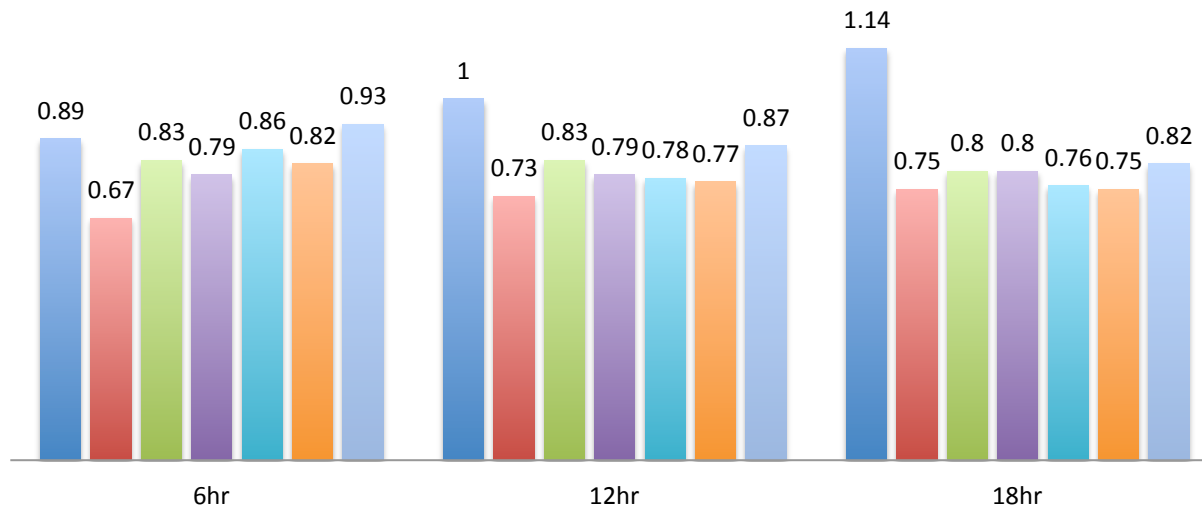
T2m T850 U10 V10 U500 V500 RH700



Warm season
May 26-31, 2013

Spread/Error ratio for different lead times

t2m t850 u10 v10 u500 v500 rh700



Cold season
Jan. 27 – Feb. 03, 2014

Pre-NARRE and WWE

- Pre-NARRE configuration implemented as a real-time system in November 2014
- The system has been prepared for participation in the WPC Winter Weather Experiment (along with 2 versions of SREF, operational and parallel)
- Real-time version includes cycling for RAP members only
- For the purpose of the winter weather experiment pre-NARRE runs only at 00Z and 12Z out to 48 forecast hours
- WWE focus on snowfall

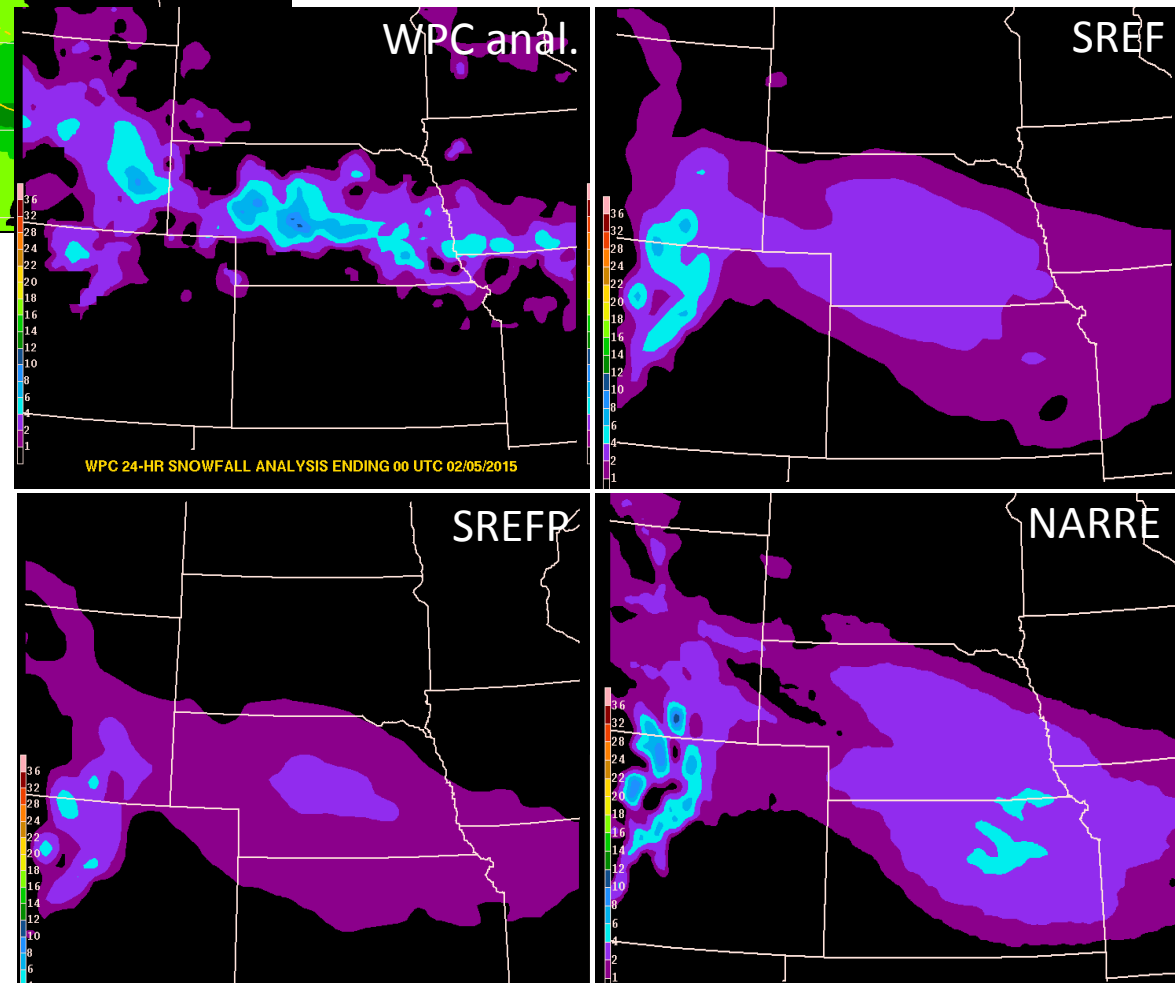
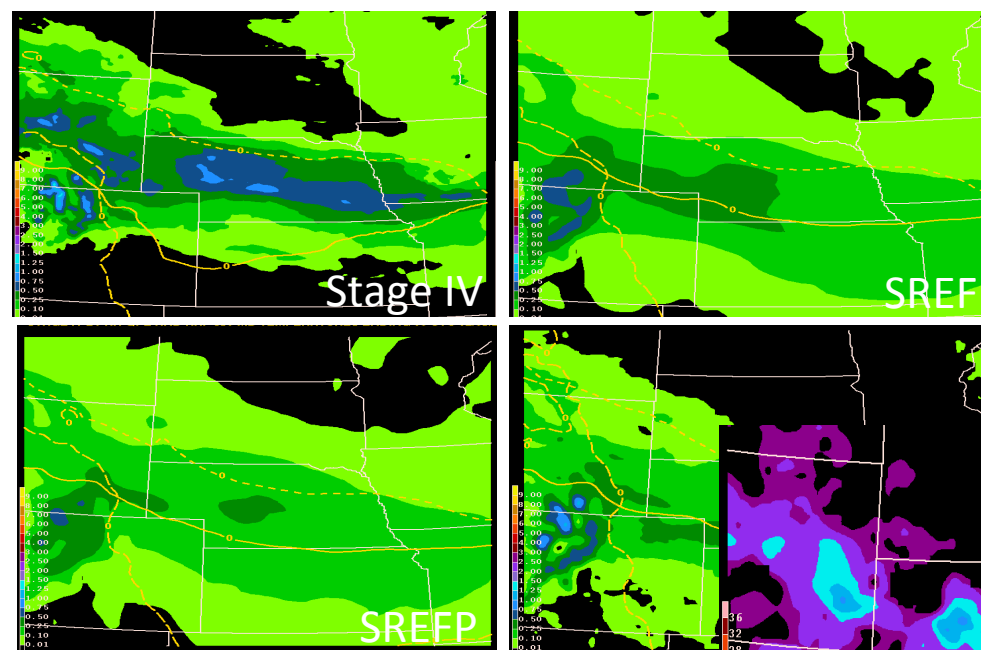
Experimental Ensemble Performance

- 24 hour mean snowfall rated by forecasters on a scale 1 to 5 ('very poor' to 'very good')
- Comparison against WPC and NOHRSC snowfall analysis
- Comparison between operational SREF mean, parallel version of SREF mean and NARRE mean snowfall
 - SREF parallel vs. SREF
 - 26 vs. 21 members
 - two vs. three dynamic cores (ARW and NMMB, NMME has been excluded)
 - more variations in physics
 - three different analyses
- All the mean forecasts were generated using the same snowfall post-processing (EMC 2m temperature SLR algorithm) deployed in SREF
- Data outages for NARRE (only 17 out of 42 cases available)
- NARRE 48-hr forecasts (which is in WPC considered day one)

$$\text{Snowfall} = (SWE) \times (SLR_{RF}).$$

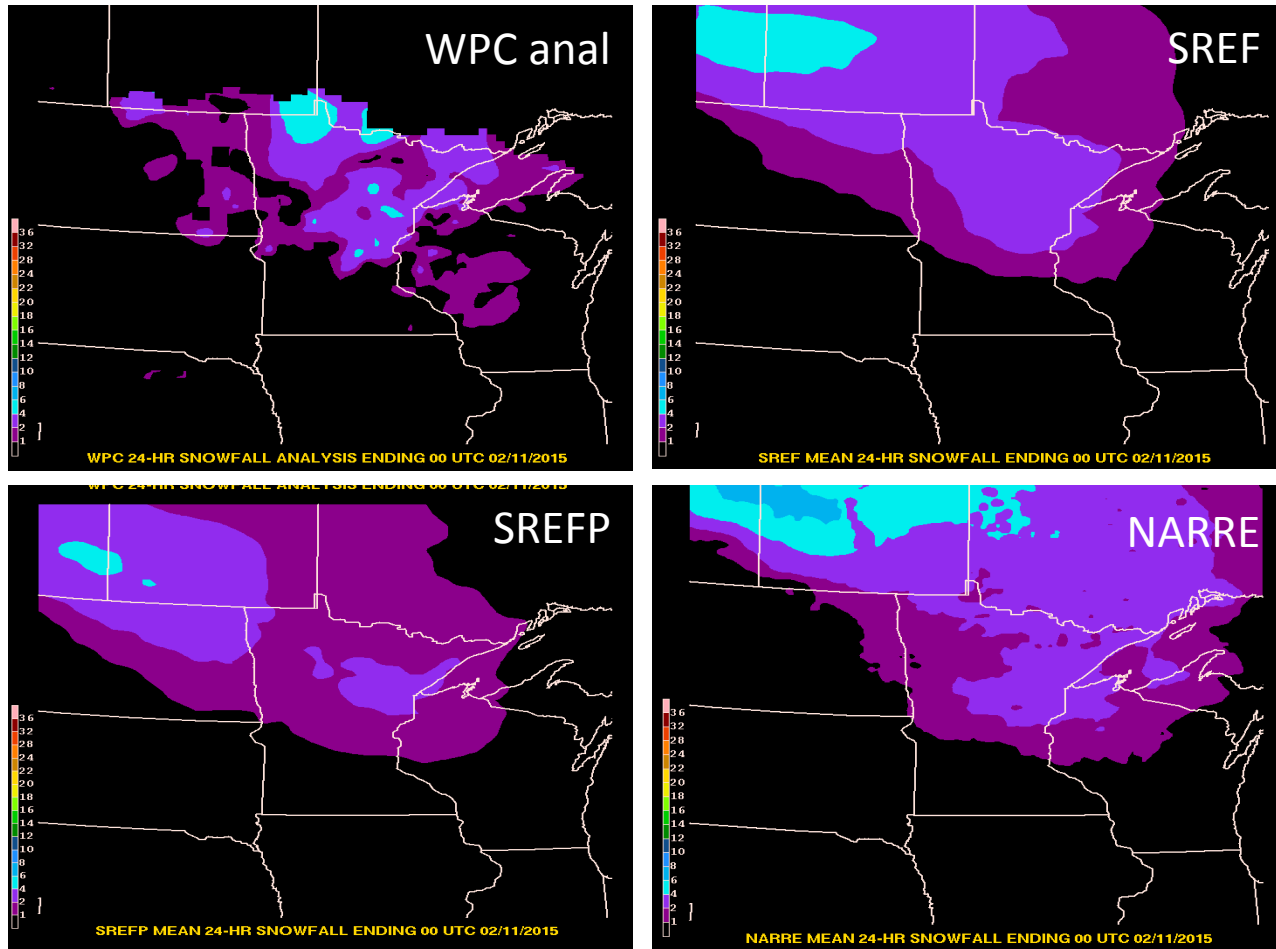
$$SLR = .5(273.15 - T_{2m}) + 8$$

Examples: 24 hr QPF and Snowfall forecasts valid at 00Z Feb. 05, 2015



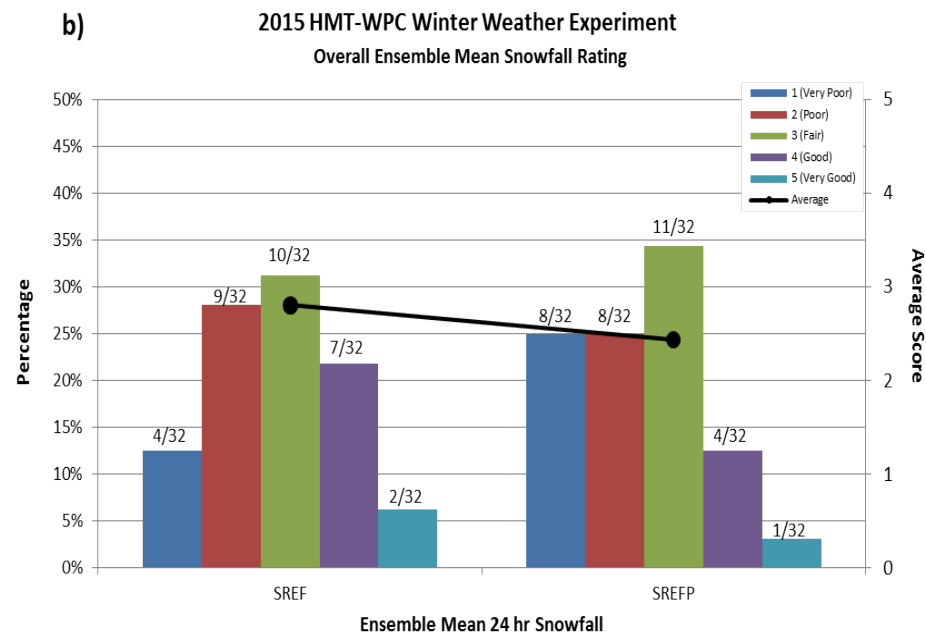
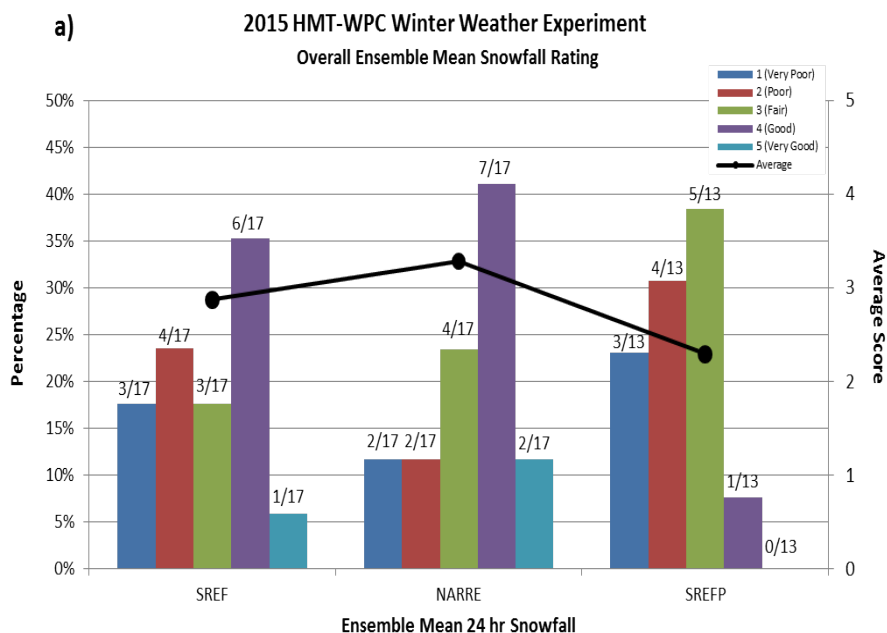
Participants noted that NARRE place the heaviest snow (and QPF) much too far south (especially NMMB solutions). Too much spatial coverage of snowfall in Nebraska.

Examples: 24 hr Snowfall forecasts valid at 00Z Feb. 11, 2015



Participants noted how the NARRE did well pushing most of the snowfall (and QPF) into Minnesota. Both the SREF and SREFP had higher snowfall amounts in western MN and back into North Dakota, where it was not observed. This was a pretty marginal snowfall case, but participants really liked how the NARRE showed that temperatures in North Dakota would likely to be too warm for much accumulating snow, which ended up being correct.

Experimental Ensemble Performance Summary



Percentage of ratings assigned to the 24 hour ensemble mean snowfall guidance during subjective evaluation for (a) the 17 cases in which the NARRE was available, and (b) the 32 cases the SREF was available. The black dots and solid black contour represent the overall average score for each ensemble system during the experiment

Future Steps

- Infrastructure for NAM RR will be available soon
 - NAMRR infrastructure (Jacob Carley and Jamie Wolff)
- Have Rapid Refresh system fully in place
- New physics options available in NAM for testing of physics impact
 - RUC LSM
 - Thompson Microphysics (Jamie Wolff)
- Testing of stochastic physics approach in NARRE (SREF-RR)
- Planned activities for this year will help transition to HRRRE

Thanks!!!